The American STATISTICIAN

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AMERICAN STATISTICAL ASSOCIATION

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35 CENTS

The American STATISTICIAN

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The news publication of the American Statistical Association

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ASSOCIATION ACTIVITIES

Committees on Statistics in the Social and Physical Sciences Planned

The Board of Directors, at its meeting of October 20, 1950, accepted the recommendation of W. Edwards Deming to establish an ad hoc committee on Statistics in the Physical Sciences. Members interested in this area are invited to get in touch with Dr. Deming.

At the same meeting, the recommendation of Philip M. Hauser to establish an ad hoc committee on Statistics in the Social Sciences was approved. This committee will cooperate actively with the American Sociological Society's committee on statistics.

It is expected that both committees will be active in planning special sections of the 1951 Annual Meeting program and that if sufficient interest is found among the membership, that they might result in the formation of sections in their fields.

The Appreciation of the Board of Directors Extended to Chairman of Program and Public Relations Committees

The Board of Directors at its October 20, 1950, meeting "voted unanimously to extend the thanks of the Board of Directors to Mortimer Spiegelman and his committee for the excellent program prepared for the December meeting."

It was also voted unanimously to extend the thanks of the Directors to Alfred N. Watson for the excellent work of his committee in publicizing the work of the Association and in planning the press relations for the Annual Meeting.

Editorial Boards of Association Publications Approved by Board of Directors

W. Allen Wallis, Editor of the *Journal,* presented the following slate of Associate Editors of the *Journal,* which was approved unanimously by the Board of Directors: Howard L. Jones, Lester S. Kellogg and William G. Madow for the terms ending December 1951; Albert H. Bowker, Solomon Fabricant and Frederick Mosteller for the terms ending December 1952.

It was also agreed that Professor Wallis would list the names of referees at the front of the *Journal* and would establish an Advisory Panel of former *Journal* editors.

Sylvia Weyl, Editor of *The American Statistician,* presented the following slate of editors for 1951 which was unanimously approved by the Board: Churchill Eisenhart and Morris Ullman as members-at-large of the Editorial Committee: Kenneth Haemer as Editor of the section on presentation problems, Frederick Mosteller as Editor of the Questions and Answers Section, Harry V. Roberts as representative on the Section on the Training of Statisticians and Lila F. Knudsen as representative of the Biometrics Section.

It was noted that there is, at present, no official nominee of the Section on Business and Economic Statistics to serve on the Editorial Board of *The American Statistician* and it was agreed that Lester S. Kellogg, who has been a member of its Editorial Board since 1947, would continue to serve until such time as the section appoints an official representative.

New Pamphlet Describing the ASA Available for Distribution

As a part of the general promotional work of the Association, a pamphlet describing the history, program and activities of the American Statistical Association has been prepared by the Secretary's Office in cooperation with Samuel S. Wilks, 1950 President of the Association. This pamphlet is available to Chapters, or individual members of the Association, for use in promoting Association membership. Copies may be obtained by writing to the Office of the Secretary, 1108 16th Street, N. W., Washington 6, D. C.

NEWS

Consumer Price Index Changes Announced—Dorn Appointed Chairman of 1951 Program Committee—Positions, Fellowships and Grants Available—1951 Midwestern Regional Conference—Government Statistical Programs in Progress

Harold F. Dorn appointed Chairman of the 1951 Annual Meeting Program Committee

Dr. Harold F. Dorn, of the Institutes of Public Health, has been appointed Chairman of the 1951 Program Committee by President-elect for 1951, Lowell J. Reed. The central core of the program is being planned around the general theme, "Statistics of the Development of Man." Anyone interested in participating in the planning of sessions or in presenting papers is invited to get in touch with Dr. Dorn at the National Institutes of Health, Rockville Pike, Bethesda 14, Maryland.

The 111th Annual Meeting will be held in December 1951, in Boston, Massachusetts at the Copley Plaza Hotel.

Consumers Price Index

Plans for improving the method of calculating the Consumers Price Index were outlined by Ewan Clague, Commissioner of Labor Statistics in a memorandum to users of the index dated October 24.

"For the past several years the Bureau of Labor Statistics has been engaged in a large-scale project looking toward the revision and modernization of the basis of compiling all of its price indexes, to make them more accurate measures of price changes. The revision of the Wholesale Price Index and the Daily Index are scheduled to be completed this year, and the revision of the Consumers' Price Index is scheduled to be completed by the middle of 1952. The details of this program have been widely publicized in order that users of the index might expect some changes at that time. * * * The economic stabilization legislation passed by Congress requires careful comparison of current and future prices with those which existed prior to June 25, 1950. These developments make it absolutely essential that the Consumers' Price Index be as accurate a measure of today's and tomorrow's price movements as we are able to make it. Therefore, we are planning to introduce into the index certain modernizations and improvements which can be made immediately.

For example, we are planning to correct a downward bias in the rent index, which we have recognized for some time but only now are able to measure. (The amount of that correction was published with the release of the October index in November.) As another example, we are planning to use 1950 Census figures, instead of earlier population estimates, in weighing together the city indexes into the all-city index. Only such changes will be made as can be shown to result in improvements in the index.

These improvements in the index cannot be completed for several months. Nevertheless, they must date back to the period prior to Korea. Accordingly, the Bureau must do two things: (1) publish the index on the present basis for some months to come; and (2) when the improvements are introduced about the turn of the year, revise the published index back to some month of 1950 prior to the outbreak in Korea. The Bureau expects to publish both the present and the revised indexes during 1951, at least.

Information will be issued to users of the index when the changes are introduced. In addition, a complete description of the extent and character of these interim improvements will be published in the *Monthly Labor Review* about the time the revised indexes are published.

Committee to Advise on Statistical Methods of the Institute for Sex Research

At the request of the National Research Council, The American Statistical Association has appointed an Advisory Committee to the N. R. C. Committee for Research in problems of sex. The committee has been set up as a sub-committee of the Commission on Statistical Standards and Organization, and will advise the N. R. C. Committee concerning statistical aspects of the research methods of the Institute for Sex Research of Indiana University, led by Dr. Alfred C. Kinsey.

Samuel Weiss designated Chief of newly established Office of Statistical Standards at BLS

Growth in the scope and technical complexity of the regular program of the Bureau of Labor Statistics, together with present and anticipated work in the area of defense and economic stabilization, have promoted a number of changes in the Bureau's organization.

For the first time in the history of the Bureau, an office of statistical standards has been organized of which Samuel Weiss, formerly Chief of the Division of Employment Statistics, has been designated Chief. He will be responsible for improving statistical methodology and developing standards for statistical work throughout the Bureau.

Postdoctoral Fellowship

Women with the equivalent of a Ph.D. degree, carrying on research in the mathematical, physical, or biological sciences, who need financial assistance and give evidence of high ability and promise are eligible for the postdoctoral fellowship of Sigma Delta Epsilon. This fellowship carries a stipend of $1,600. During the term of her appointment, the appointee must devote the major part of her time to the approved research project and not engage in other work for remuneration (unless such work shall have received the written approval of the Awards Board before the award of the fellowship).

Application blanks may be secured from Dr. Mayme I. Logsdon, The University of Miami, Coral Gables 46, Fla. Announcement of the award will be made early in March.

Positions Available in Inter-Industry Economics Research

The program for the statistical implementation of this experimental technique for making industrial mobilization projections has been expanded and accelerated as a result of the present international situation. Supporting developmental research projects will be undertaken by many federal statistical agencies, most of which will hire additional statisticians and economists for this purpose. Both from the immediate and the long-range point of view, it is desirable for persons interested to be accredited on open Civil Service registers. Economist U209 and EC13 registers at salaries ranging from $3,825 to $10,000 are now open. The program as a whole, is under the direction of an Executive Office Committee. Personnel inquiries may be addressed to the Division of Statistical Standards, Bureau of the Budget, which is responsible for planning and coordinating this research.

Mid-western Regional Conference in June 1951

A Mid-western Conference of the ASA is planned for June 1951; Edward Cushman is Chairman and is working on the planning of the Conference which will be held at Wayne University, Detroit, Michigan.

University Bureaus of Business and Economic Research

For the year 1951, the Associated University Bureaus of Business and Economic Research have chosen the following officers: President, John H. Cover, University of Maryland; Secretary-Treasurer, Henry B. Moore, University of Colorado; Directors, F. L. Carmichael, University of Denver, William T. Hicks, University of Georgia, Frank Kidner, University of California, Lorin A. Thompson, University of Virginia, and George W. Starr, Indiana University.

This year's meeting was held at Boulder, Colorado. The 1951 meeting is scheduled for New Orleans, Louisiana.

Utah State Agricultural College Inaugurates New President

Professor Clinton L. Oaks, of the Department of Economics of the College of Business of the University of Utah, was the official representative of the American Statistical Association at the Inauguration of Dr. Louis Linden Madsen as Eighth President of Utah State Agricultural College on November 3, 1950.

Utah State Agricultural College is one of the American Land-grant colleges, "established by an Act of the Legislature of Utah Territory passed on March 8, 1888."

Professor Oaks extended to President Madsen congratulations and best wishes from the Officers of the American Statistical Association.

Social Science Research Council Fellowships and Grants for 1951

The SSRC has announced that prospective candidates may now apply for research fellowships and area research training fellowships.

Grants-in-Aid of research are offered to help individual investigators meet the expenses of their own projects. They are available only to mature social scientists who are not candidates for academic degrees and whose capacity for productive research has been demonstrated by publication. Purposes for which grants-in-aid may be expended include wages for clerical and technical assistants; tabulating, microfilming and photostating and similar services; transportation and living expense of the grantee while traveling in pursuit of his investigation. Grants will not be given to subsidize the preparation of text books or the publication of books or articles or to provide income in lieu of salary. Grants may not be in excess of $1,500.

Applications should be *filed not later than January 15, 1951,* for awards to be made on or about April 1st. No funds are available at other times of the year.

Area research training fellowships are offered for advanced training for preparation in research clearly related to understanding of the contemporary culture of a major world area outside the United States, such as the Far East, Southern Asia, Russia and neighboring Slavic countries, the Near East, Africa, Latin America and the Caribbean, Europe and other major foreign areas. Preference will be given to applications for work in the fields of the social sciences (anthropology, economics, history, human geography, political science, social psychology, and sociology) but applications may also be considered for work in closely related fields of the humanities and natural sciences.

While fellowships will normally be awarded for research outside the United States, they may include a preparatory study in this country, such as languages or a supervised program of preparation for research in the foreign area. Candidates for such a fellowship must submit a program of study and research which relates directly to the better understanding of present-day conditions of a world area and its people. Fellowships are normally awarded for one year, but a program covering a longer period may be submitted in the original application. Basic stipends at the rates of $2,500 for predoctoral and $3,500 for postdoctoral fellows may be supplemented to provide for the maintenance of dependents, travel and other necessary expenses; or may be adjusted to take account of partial support from other sources. Applications should be *filed not later than January 15 or August 15, 1951,* for grants given in April or October, respectively.

Travel grants for area research are offered only to mature scholars of established competence as specialists on the contemporary culture of a major world area outside the United States. These grants, which may not normally exceed $2,500, are designed to cover the expense of travel to and in the areas of interest and may provide for other research and field-work costs, but do not provide for full maintenance of grantees and their dependents or for transportation of dependents. Research programs submitted in applying for these grants should cover at least six months' work, and should preferably cover a full year or more. Candidates for academic degrees are not eligible to apply for travel grants. Applications should be *filed not later than January 15 or August 15, 1951,* for awards in April or October, respectively.

Faculty research fellowships will be awarded to approximately 10 persons in 1951, for three-year terms. These awards are designed to enable young members of social science faculties, whose superior qualifications have been demonstrated by outstanding research already accomplished, to devote one-half or more of their time to self-directed research while remaining in residence in their own institutions while carrying on a restricted amount of teaching. Consideration will normally be limited to faculty members of universities and colleges in the United States who are not over 35 except in the case of those whose careers have been delayed by prolonged war service.

As the *active cooperation of a university or college* in question will be essential, each nomination must be submitted by a senior member of the institution who can undertake to secure the necessary commitments if an award is offered. *January 15, 1951, will be the closing date* for the receipt of nominations, but it would be appreciated if nominations were submitted well in advance of that date.

Application forms and circulars giving full details may be obtained from the Washington Office of the Social Science Research Council, 726 Jackson Place, N. W., Washington 6, D. C.

University of Illinois

To supply the growing need in many fields for personnel with a major interest in statistics, the University of Illinois has instituted a graduate program leading to the Master of Arts or to the Ph.D. in Statistics.

Administered by the department of mathematics, the new program includes both statistical theory and its application to a specific field of interest. Considerable flexibility is possible in the division of emphasis between theory and its application, but in no case will the amount of work in the latter area be less than that for a minor.

Under the new program a student who wishes to concentrate on research in statistical methods will have a choice of areas in which his thesis may be written, depending on his major interest. Each student will have two advisers, one in statistical theory and the other in his area of application, one of whom will be in charge of his thesis.

Beyond the regular Graduate College stipulations, the only special requirement for admission to the program is completion of a thorough course in calculus. For the Ph.D. degree a student, in addition to language and other standard requirements, must show capacity for important original contributions in statistical methods or in application of such methods.

The brief reports which have been gathered here under the general title, "Current Statistical Projects of the U. S. Government" have been prepared with the cooperation of Mrs. Virginia Venneman of the Division of Statistical Standards of the Bureau of the Budget, who is Government Correspondent for The American Statistician.

National Income and Product—1942-49 Tables

The economic functioning of the United States economy in the war and postwar years is reviewed statistically in the Department of Commerce *Survey of Current Business* for July 1950, which contains the 1942-49 tables of the national income and product. An industrial classification distinguishing 69 industry groups is applied to national estimates of employee compensation, corporate and noncorporate business net income, employment, and related series. Gross national product is traced from origin to ultimate disposition in terms of the four sectors of the economy (business, government, persons, and the rest of the world), and the composition of each domestic sector's ultimate share is detailed by budget category or object class. Auxiliary tables pertain to governmental and social insurance finance, private saving and investment, average earnings per employee in various industries, business inventory shifts, etc. Monthly values are given for personal income and its components, and quarterly totals for other major aggregates.

The series presented in the July 1950 issue of the *Survey of Current Business* are available for the 1929-41 period from the National Income Supplement to the July 1947 *Survey*. The National Income Supplement also includes table footnotes and explanations of the concepts, terminology, and general framework underlying the official income and product estimates.

Harlow A. Osborne, Office of Business Economics, Department of Commerce.

Survey of School Health Services

The Office of Education, in cooperation with the Public Health Service (Federal Security Agency), is making a mail survey of health services in city school systems to obtain information on types and frequency of medical and dental examinations given to school children and on health personnel. A survey made last year by the Office of Education identified the 90.5 percent of city school systems which have school health services. For the present study, a questionnaire is being mailed to all the 1,000 larger cities (population of 10,000 and over) and half of the 1,900 smaller cities (population of 2,500 to 10,000) with such services. The questionnaire is being mailed by the Office of Education to school superintendents in cities where the health program is administered by the schools, and by the Public Health Service to local health departments where the program is administered by them.

A companion survey, addressed to county medical societies, is being made by the American Medical Association to cover the relationship of such societies to the local school health programs. The two surveys together will provide a moderately complete picture of the health services available to city school children.

Herbert S. Conrad, Office of Education, Federal Security Agency.

Standard Definitions of Metropolitan Areas

Standard definitions for 172 metropolitan areas, each containing at least one city with a population of 50,000 or more, have been developed by Federal Government agencies and announced by the Bureau of the Budget. These definitions are recommended for use by all Federal agencies in compiling general purpose statistical data. It is believed that State and local governments and private industry or research organizations will also find them useful, especially when comparability with basic data compiled by Federal agencies is desirable.

The definitions are designed to serve a wide variety of purposes, including the presentation of statistics on population, industry and trade; employment and payroll data; and local labor market analysis. Consequently, the standard metropolitan area is designed to represent an integrated economic unit with a large volume of daily travel and communication between the central city and the outlying parts of the area. This results in an area considerably more restricted, especially in the case of the larger metropolitan centers, than the trading area or area of economic influence of the central city.

Each area (except in New England) consists of one or more entire counties. The county, rather than minor civil divisions, was chosen as the basis for the definitions because of the availability of different types of data on a county basis. In New England, where the basic geographic unit for statistical compilations is frequently the town, the metropolitan areas were defined on the basis of towns rather than counties.

The use of county units sometimes results in the inclusion in a standard metropolitan area of a considerable amount of territory which is not "metropolitan" in the usual sense. For the presentation of social and economic statistics this is of little importance, since the population in such territory is usually negligible in relation to the population of the area as a whole. In the presentation of statistics relating to land area, on the other hand, this characteristic of the standard definitions would constitute a serious weakness, and their use for such purposes would ordinarily be inappropriate.

The definitions were initially proposed by the Bureau of the Census, discussed with interested local organizations, and reviewed and approved by an interagency committee representing nine of the principal producers and users of area data. Pending a check against final population figures from the 1950 Census of Population, the list now contains definitions of all areas including cities with a population of 50,000 or more. A description of the principles followed in defining the areas and of the standard definitions for each area may be obtained from the Bureau of the Budget, Washington 25, D. C.

Thomas J. Mills, Division of Statistical Standards.

Study of Veterans' Participation in Major Benefit Programs

The Veterans Administration is conducting a study to determine the extent to which the same veterans have participated in several of its major benefit programs, the value of benefits received under two or more programs, and the number of veterans who have not participated in any of these benefit programs. These program-participation data will also be correlated with other available information, such as age and length of service, to ascertain the nature of the patterns of participation. The benefit programs included in the study are: disability and death compensation and pension; education and training; vocational rehabilitation; hospitalization; outpatient medical and dental treatment; loan guaranty; and readjustment allowances.

The study will cover the records of about 16,000 persons, representing a sample of about one-tenth of one percent of those who were separated from the armed forces after service between September 16, 1940 and July 25, 1947. The study sample was selected from the Master Sample of Armed Forces Separations maintained by the Research Division of the Veterans Administration.

Harry Hoffner, Research Division, Coordination Service, Veterans Administration.

A Model to Aid in Teaching Partial Correlation

by HELEN M. WALKER, Teachers College, Columbia University,
and WALTER N. DUROST, Boston University

The Data: The height, and age data for Glasgow school boys, gathered by Miss Ethel Elderton and published in Vol. 10 of *Biometrika,* were used in making the correlation model. The original form of these data proved less convenient than the redistribution made by Isseralis and reported in Vol. II of *Biometrika* so that the latter was employed. Age levels 7 to 13 only were used.

The Construction: Seven plates of demi-plate glass approximately 8 inches by 20 inches, were built up in skyscraper fashion, each being separated from the other by four small rubber feet. (See Figure 1). Upon each plate the frequency distribution for the correlation between height and weight for a given age was plotted, using for the purpose Dennison gummed numbers. The distribution was first plotted on a chart the size of the plate, then the glass was superimposed upon this chart, and the numbers placed over the proper cells as indicated through the glass. The regression lines, first drawn on the charts, were represented on the glass by narrow strips of passepartout tape, one color being used for the regression of height on weight and a different color for the regression of weight on height. There seemed to be no available way to show the regression relative to age.

The distribution for the zero order r between height and weight was drawn on tracing cloth and this is used as the base on which the model rests. The intersection of the mean height and mean weight for the total group is indicated on each plate by a cross in red, and the intersections of the means for each group indicated by a small star on the plate for that year.

The completed model is housed in a cabinet which has a false bottom of glass beneath which electric light bulbs have been placed, thus permitting the model to be seen under optimum conditions.

Obviously this construction is not wholly satisfactory but describing it may induce someone else to experiment with some of the new materials which were not available when it was made. The frequency density is not shown here, but only suggested. One might be able to show the frequency density if frequencies were indicated not by number symbols but by groups of tiny colored dots. The frequencies we used were too large to be easily represented thus, but using a larger number of layers and thus making the interval on the vertical trait smaller would reduce the size of the frequencies and further the effect of a continuous distribution.

The use of modern materials which were unknown at the time this model was constructed would probably reduce labor and result in a lighter model, easier to move about, and less likely to be broken.

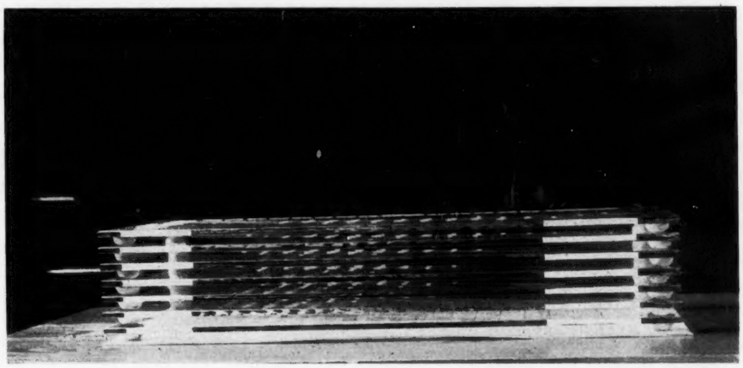
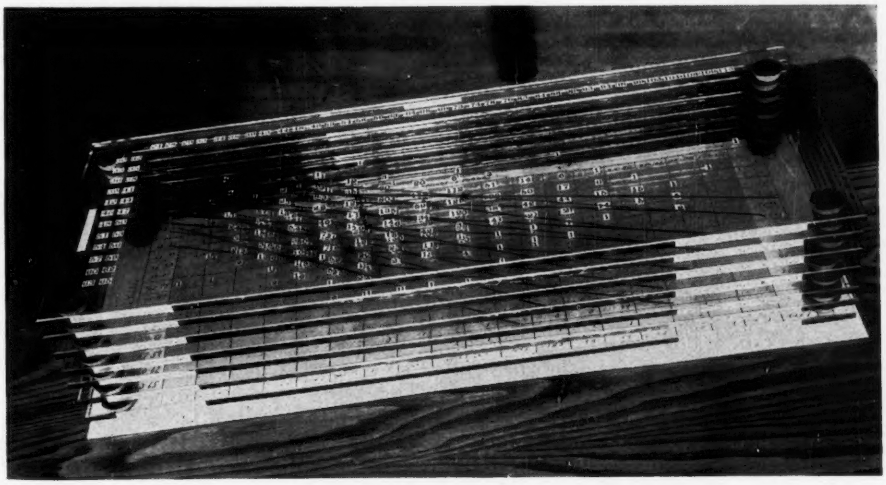


FIGURE 1

FIGURE 2



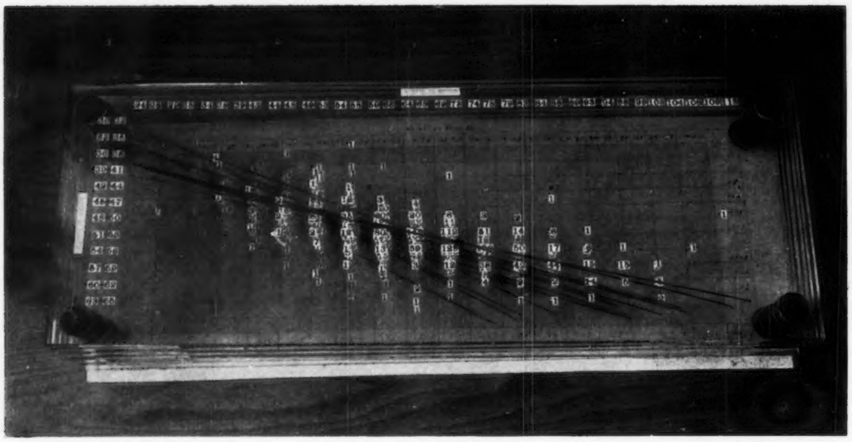
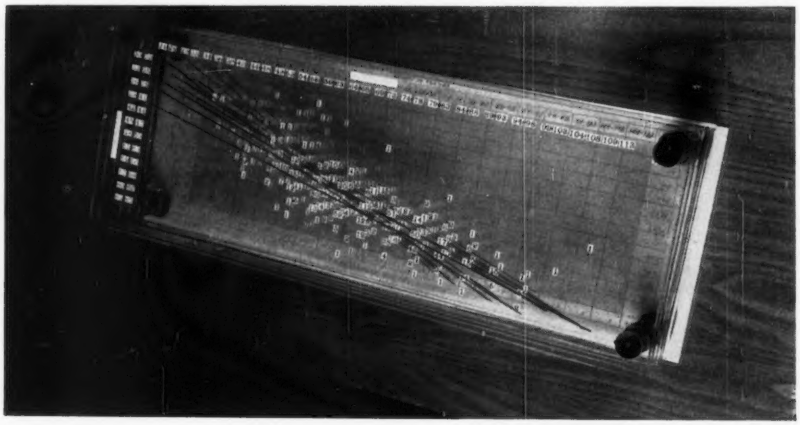


FIGURE 3

FIGURE 4



order correlation between weight and age by a horizontal projection upon the longer side of the cabinet.

Upon each of the seven sheets of plate glass is the correlation distribution of height and weight for a single age group, and thus each one *approximates* the partial correlation between height and weight with age held constant. These correlations are of course not strictly uniform for the different ages, and no one of them could be taken as identical with the partial correlation. Furthermore, in each section age varies slightly, within the narrow limits of one year, so for this reason also we cannot say that the correlations represented on the various sheets *are* the partial correlation, but only that they suggest and approximate it.

If vertical sections are taken through the mass at right angles to the weight axis, each being one weight-interval in width, each such section is seen to contain a distribution of the height and age for children of approximately uniform weight. Thus we get a picture suggesting the partial correlation between height and age when weight is constant. The partial correlation of weight and age with height held constant is suggested by taking vertical sections through the mass at right angles to the axis of height.

Partial and Zero Order Correlation: First of all, this model helps the beginner to visualize a three-way distribution of frequency, to see the two-way distribution with which he has been working open out into a third dimension when measurement is made on a new variable. Thus it prepares him for the analytical consideration of problems dealing with many variables, bridging the gap between the two-dimensional scatter diagram of which he has graphical comprehension and the multivariate regression problems which the student not trained in mathematics sometimes finds very puzzling.

The zero order correlation between height and weight is represented by a scatter diagram plotted on a sheet beneath the model, this scatter diagram showing the vertical projection of all the seven separate diagrams on one single plane. The zero order correlation between height and age could be represented by a horizontal projection of all the scores upon the narrow end of the cabinet and the zero

Regression Lines and Planes: For each age level, lines have been drawn to show the regression of height on weight and of weight on height. The seven lines for the regression of weight on height indicate a surface, the regression surface for estimating weight from height and age. This surface is not a plane, but is warped. If curved regression lines had been fitted on each plane, instead of lines drawn according to the usual straight line equation, there would have been a double warping. The regression surface for estimating height on the basis of weight and age is suggested by the seven separate regressions of height on weight. The best view of these surfaces is afforded by Figure 4. No way has been found to suggest either the third plane or any of the regression lines which involve age. The small stars which are placed at the intersection of the mean height and mean weight for each age fall very nearly on a straight line,

which is the intersection of the two regression surfaces portrayed. The mean height and mean weight for the entire table is indicated by a small cross on each plate, the crosses lying in a vertical line. These two lines, the one vertical and the other oblique, intersect at a point where the third regression surface—if it could be shown—would cut the other two.

Variation Around Regressed Values: The total mass may be thought of as cut into narrow slices first in one direction and then in another. The portion of the mass representing individuals who have a particular height and a particular age is a long horizontal block parallel to the weight axis. In it variation in height and in age is restricted to the width of their respective intervals. All individuals whose scores fall in this strip would have the same prediction of weight made on the basis of their height and age but obviously they do not all have the same actual weight. The variation of weights within the strip is due to deviation of actual weight from estimated weight. Centering attention first on one such strip and then on another, one can build up a sense of the variation of observations around a regression plane.

QUESTIONS and ANSWERS

edited by FREDERICK MOSTELLER
Harvard University

"LIFE TESTING"

Question 29. This inquiry stems from an example given by Jacobsen ["The relative power of three statistics for small sample destructive tests," *Journal of the American Statistical Association, 42* (1947), pp. 575-584], in which five fuses are placed in a testing panel and the blowing current is observed for the first three fuses to blow. He states that the mean of the three smallest observations in a sample of five is as good, for control purposes, as the mean of four observations in a sample of four. Thus, information equivalent to four units is obtained at the expense of only three units.

We have a similar problem in testing the folding endurance of paper, but our problem is to save time rather than material. Some of our papers have very great folding endurance, and samples sometimes come into the laboratory faster than they can be tested. I am wondering how the mathematics would work out if we tested two strips at a time (on two machines) and stopped both tests as soon as one sample had broken. If we tested three pairs in this way, we would have the smallest observation in each of three pairs making up a sample of six. I would like to assess the relative amount of information in such a procedure. It seems to me that this would give more information in less time than running three individual samples to the breaking point, but how much more I cannot tell.

Answer. We are not told about the distribution of your folding results. Without further investigation, a reasonable guess might be that the distribution of the logarithm of the number of folds, rather than the number of folds themselves, is approximately normal. If this is the case, we might apply normal distribution theory to your question, assuming that you would plot logarithms and averages of logarithms on your quality control chart. If this assumption is good enough for practical procedure, we can assume that the distribution of the logarithm of the smallest observation has moments approximately like those given for the normal in either of the following papers: "Low moments for small samples: a comparative study of order statistics" by Hastings, Mosteller, Tukey, and Winsor, *Annals of Mathematical Statistics, 18* (1947), pp. 413-426; and "Some low moments of order statistics" by H. J. Godwin, *Annals of Mathematical Statistics, 20* (1949), pp. 279-285. Then the smallest observation in a sample of two will be approximately .5642 standard deviations below the true mean of the distribution. The variance of that observation will be approximately .6817 times the variance of the original distribution. If you take three independent pairs and record only the lowest in each pair, the variance of the mean of these three observations will be $.6817/3 = .2272$ times the variance of the original distribution. Had one had four single observations, the variance would be about .250 times the variance of the original distribution, while for five observations the multiplicative factor would be about .20. Thus the average of the three lowest in three samples of two is about as good for control purposes as 4.4 individual observations. One disadvantage is that one no longer has an estimate of the standard deviation within samples, since there is only one observation per sample.

A difficulty arises if different machines are used for each of a pair of samples. It is essential that the two machines have equivalent settings, and this can only be verified by experiment. If there are two machines you should maintain a record telling you for each pair which machine finished first. Over a period of time the two machines should each have half of the first observations of a pair, otherwise some adjustment needs to be made. If one machine is always finished first, you are really taking a single observation from a sample of size one, and you have lost the benefit of the procedure entirely.

NEW LEGISLATION ON FEDERAL STATISTICAL COORDINATION

by STUART A. RICE
Assistant Director in Charge of Statistical Standards
Bureau of the Budget, U. S. Government

The statutory authority for coordination of Federal statistical programs has been considerably strengthened by the recent enactment of the Budget and Accounting Procedures Act of 1950 (P.L. 784), which includes the following section:

Government Statistical Activities

Sec. 103. The President, through the Director of the Bureau of the Budget, is authorized and directed to develop programs and to issue regulations and orders for the improved gathering, compiling, analyzing, publishing, and dissemination of statistical information for any purpose by the various agencies in the executive branch of the Government. Such regulations and orders shall be adhered to by such agencies.

Inclusion of this section on statistical activities in the Budget and Accounting Procedures Act is appropriate because of the location of the agency responsible for statistical coordination—the Division of Statistical Standards—in the Bureau of the Budget. The new act, which is directed primarily at modernizing and simplifying governmental budgeting, accounting and auditing procedures, incorporates many of the recommentations made by the Commission on Organization of the Executive Branch of the Government in its report on Budgeting and Accounting. This report included the Commission's recommendation "that authority be given to the President to effect improvements in statistical activities" and that such authority be delegated to the Director of the Division of Statistical Standards in the Bureau of the Budget.

The Commission's recomendations on statistical services resulted from the report made by its special task force on government statistical agencies. This task force, which consisted of Frederick C. Mills and Clarence D. Long of the National Bureau of Economic Research, made the first comprehensive evaluation of Federal statistical services since the study of government statistics in the mid-30's by the Committee on Government Statistics and Information Services (COGSIS), sponsored jointly by the American Statistical Association and the Social Science Research Council.

Like the earlier COGSIS report, the Hoover Commission recognized the desirability of continuing the division of labor and decentralization of authority among the various statistical agencies and the necessity of effective centralized supervision of statistical activities. COGSIS recommended continuation and expansion of the Central Statistical Board (the statistical coordinating agency which had been created in 1933, and which was transferred in 1939 to the Bureau of the Budget, where it became the Division of Statistical Standards). The Hoover Commission stated that the coordinating function of the Division of Statistical Standards should be strengthened, and that there should be sufficient authority to compel reforms. The Commission noted defects in the present system—such as overlapping or duplication of reports, excessive detail or delay in publication, gaps in coverage, and lack of comparability—and concluded that these could best be remedied by strengthening the Division of Statistical Standards to supply effective central direction and supervision of statistical activities, with authority to see that coordination is achieved.

In presenting the bill before the Senate, Senator John L. McClellan, Chairman of the Committee on Expenditures in the Executive Departments, made the following statement concerning the section on Government Statistical Activities:

> Because of the importance of accurate statistical data as a basis for informed policy decisions, because of the need for accurate and prompt measurements of employment, production and purchasing power, and because of the deficiencies and defects existing in our present statistical system, the Commission recommended that the authorities of the Division of Statistical Standards in the Bureau of the Budget, subject to the approval of the President, be strengthened to enable it to effect improvements in statistical activities. This recommendation is carried out in [Section 103 of the Budget and Accounting Procedures Act].
>
> The statistical services of our Federal Government are necessarily decentralized. . . . In every case the responsibility for collection

and analysis of important facts bearing on our national well-being must be assigned to the agency best equipped to carry on that work most efficiently. For this reason we must have a strong central coordinating unit familiar with the operations and needs of all agencies and able to supply competent management and direction of the Government's widely dispersed statistical activities. . . .

The new legislation differs in several significant respects from the Federal Reports Act of 1942, which also gave the Budget Bureau broad authority with regard to Federal statistics. Whereas the Federal Reports Act emphasizes the collection of information, the new act places equal emphasis upon collection, compilation, analysis, publication and dissemination. Also the new act applies to all agencies in the executive branch, whereas the Federal Reports Act specifically exempted several agencies. On the other hand the new act deals with "statistical information," whereas the Federal Reports Act covers information-collecting activities, irrespective of whether statistical.

Annual Meeting Social Activities—Especially for Wives

LINDA MORRISEY
Local Arrangements Committee

Tuesday, December 26—

There are no definite plans for this evening. Advance registration for the convention may be made to avoid the morning rush. A committee member will be on duty to suggest nearby restaurants and entertainment.

Wednesday, December 27—

Morning: Free tickets for radio broadcasts. These will be "Don McNeill's Breakfast Club," "Welcome Traveler," and "Ladies Fair"—all audience participation shows.

Afternoon: Matinee party at one of the local theatres for a good play. The list of current plays or those expected to be running in December and which are expected to have Wednesday matinees are:

1. "Diamond Lil" with Mae West.
2. "Angel in the Pawnshop" with Eddie Dowling and Joan McCracken.
3. "The Lunts."
4. Tennessee Williams' new play.

Tickets are from about $4.00 for orchestra to $1.25 for upper balcony for matinees.

Yes, "South Pacific" is playing here, but we cannot obtain a group of tickets for it. If you want to see it, we suggest that you send a check direct to the Shubert Theatre in Chicago. We want to warn you that tickets are scarce!

Other entertainments available are the Sonja Henie Ice Show (no matinees) and the Sadlers' Wells Ballet of London. Ballet tickets are at a premium, so write direct to the Chicago Civic Opera House for tickets for evening performances.

Evening: No formal dinner has been planned, but we hope groups of you will get together informally. Why not drop in to the Social Events Committee room, and obtain suggestions where some of the gang will be dining?

The big event of the evening, and, we hope the convention, will be our "Beer Party." We will have refreshments—food and drinks (alcoholic and otherwise). We want both husbands and wives and unattached men and women to attend. We think it's time the convention delegates did more than just come to the sessions—we want them to have fun together. We are inviting conventioneers from other related groups to attend and get acquainted. You will see friends from the American Marketing Association, the American Economic Association, the American Association of University Professors of Insurance, Medical Statistical Society, and the Institute of Mathematical Statistics. Tickets for the party will be $2.00 per person.

Thursday, December 28—

Morning: Free tickets again for the above radio broadcasts. We also plan to have a guided tour to points of interest in Chicago, for which the fee will be $2.00 to $2.50 per person.

Afternoon: A free guided tour of the Marshall Field Store, followed by a tea, and possibly a fashion show, in the store. There will be a small fee for the food.

Evening: Official convention banquet, which will be attended by members and their wives or guests.

Night: If you want to brighten up the evening after the banquet, we will arrange for a group to be conducted to the Chez Paree Night Club. You won't need a date to come along. Estimated cost for transportation, the show, a late supper, and dancing is $7.50 a person. Or you may go to the Sapphire Bar in the same club where you can have a highball and watch the show sans cover charge. If you elect to go to the bar, you pay your own expenses and transportation.

Friday, December 29—

Morning: More free tickets to radio broadcasts for those who did not see them before or want to go again. Another guided tour will be available to take you to a different part of the city than the Wednesday tour.

Afternoon: No activities are planned.

Evening: We have free tickets for Don McNeill's TV Show.

NEWS about MEMBERS

B

Geoffrey Beall, has left the Research Library of Swift and Company, Chicago, and is now with the Statistical Laboratory at the University of Connecticut at Storrs.

Irving Burr is on sabbatical leave from Purdue University, Department of Mathematics, and is in Ann Arbor, Michigan, working on a book on statistics for engineers.

C

Teobaldo Casanova has returned from Philadelphia to work as Director of the Clinica Psicologica in San Juan, Puerto Rico.

F. Stuart Chapin has recently relinquished the directorship of the School of Social Work at the University of Minnesota. He continues as chairman of the Department of Sociology.

Jennings P. Chu has returned to China, where he is teaching at Hangchow University at Hangchow, Chekiang.

Frank J. Corcoran is now working as a Traveling Auditor for the Public Service Coordinated Transport.

Donald R. G. Cowan has accepted an appointment as Professor of Marketing in the School of Business Administration, University of Michigan, in Ann Arbor.

D

Lewis N. Dembitz has been made Assistant Director of the new Division of International Finance of the Board of Governors of the Federal Reserve System.

E

Lillian Elveback, formerly of Columbia University, is now with the School of Public Health at the University of Minnesota.

F

John Firestone has been granted a sabbatical leave by the City College of New York and is spending a year working at the National Bureau of Economic Research as a research associate. The college has also promoted Mr. Firestone to the position of Assistant Professor.

G

Milton Gilbert who has been on leave to serve as Director of Economics and Program Department of the Joint Distribution Committee in Paris, has returned to the office of Business Economics of the Department of Commerce as Chief of the National Income Division. While abroad he was instrumental in the establishment of a national accounts unit at Cambridge, England, under the sponsorship for the organization of European Economic Cooperation.

Leo A. Goodman, formerly of the Department of Mathematics at Princeton University, is now Assistant Professor of Sociology at the University of Chicago.

K

Hildegarde Kneeland is now working as a consultant in economic research in the United Nations Statistical Office.

M

John Thornton Marshall, formerly Chief of the Vital Statistics Section of the Dominion Bureau of Statistics at Ottawa, has been made Assistant Dominion Statistician.

N

Mary B. Novick is now Visiting Associate Professor at the University of California, Los Angeles, Graduate School of Social Welfare, teaching Research Methods for Social Welfare and directing the preparation of student theses.

R

John H. Rohrer, formerly of the University of Oklahoma, is now Director of the Urban Life Research Institute at Tulane University.

S

Raymond F. Stewart has left Chicago and is now working in the Division of Journalism of Emory University in Georgia. He is working on the planning and execution of studies involving the improvement of media research.

Walter Boyd Stovall, Jr. is now in the Naval Reserve with the Underway Training Element of the U. S. Fleet Sonar School at San Diego.

W

Edward S. Weiss, formerly of the Division of Tuberculosis of the United States Public Health Service, is now with the Arctic Health Research Center at Anchorage, Alaska.

Seymour L. Wolfbein has been assigned full responsibility for the employment statistics program of the Bureau of Labor Statistics. He will continue to have over-all direction of the occupational outlook and manpower programs and these three programs will constitute a new Division in the Bureau.

The Effects of Calendar Shifts on Series of Monthly Data

by CHARLES E. ARMSTRONG

American Telephone and Telegraph Company

This is the second of two articles

Introduction

In an earlier article, the effects on monthly data of the variation from one year to another in the number of Saturdays and Sundays in a given month were discussed. In this connection a system for identifying the various types of calendar months was suggested, under which 4 Saturday, 4 Sunday months were labeled a-months, 5 Saturday, 4 Sunday months b-months, 4 Saturday, 5 Sunday months c-months, and 5 Saturday, 5 Sunday months d-months. There were also given formulae for computing calendar shift indexes for each type of calendar month from known or assumed relative values of Saturdays and Sundays, together with a table showing the indexes computed from these formulae for various values of Saturday and Sunday.

In a series adjusted for seasonal variation, the presence of consistent calendar shift effects may be a noticeable factor. The following procedure is designed to measure the probable amount of calendar shift effect present in a series directly by observing the seasonally adjusted data. The process here outlined is based on the link-relative approach, but it is readily adaptable to deviations from a moving average.

Procedure

I. Label the months in the series as a, b, c, or d-months, in accordance with the system earlier discussed.

II. Compute link relatives of the seasonally adjusted data[1]. (A link relative is the percentage obtained by dividing the datum for a given month by the datum for the preceding month.) Disregard February, the March relative being computed by dividing the March datum by the January datum.

III. Step II will result in 5 types of link relatives, a/d, d/a, b/a, c/b, and a/c. Make a separate list of each of these five types of link relatives. (Disregard a/a relatives which frequently ocçur, and a/b, b/c, and c/a relatives which may occur in leap-years.)

IV. Compute a broadened median[2] or other suitable measure of central tendency for each of the five types of link relatives. In this step, a time series chart may prove helpful in setting representative central values[3].

V. Divide the a/d and d/a broadened median values, determined in IV, by the square-root of their product and multiply by 100. Likewise, divide the b/a, c/b and a/c values by the cube-root of their product and multiply by 100. This procedure adjusts for any trend effect or bias in the ratios.

VI. Using the adjusted values in V, compute a d/c value as $(a/c \times d/a) \div 100$.

VII. Theoretically, b/a and d/c should be approximately equal, since both ratios reflect the excess or deficit of the value of a Saturday over that of a week-day. If they are not equal (and in practice they seldom will be), substitute the average of the two for each of them.

VIII. Using the adjusted values of a/d and c/b determined in V, and the b/a and d/c averaged value determined in VII, apply the following version of the link-relative process:

(1)	(Links)	a/d	b/a	c/b	d/c	(Here b/a=d/c)
(2)	(Chain)[4]	a/d	b/d	c/d	d/d=	100 (Check)
(3)	(Weights)[5]	.48	.14	.14	.24	Weighted Average of (2) ——————
(4)	(Indexes)	a	b	c	d	(2) $\div$ Weighted Average $\times$ 100

IX. These indexes apply to all months except February, and may be applied directly to the series under study.

They reflect relative values of Saturdays and Sundays as compared with week-days,[6] which may be computed approximately as follows:

$$\frac{\text{Saturday}}{\text{Week-Day}} = 1 - \frac{30.66\ (a-b)}{100+4.38\ (a-d)}$$

(These values may be expressed as percentages.)

$$\frac{\text{Sunday}}{\text{Week-Day}} = 1 - \frac{30.66\ (a-c)}{100+4.38\ (a-d)}$$

X. Basic[7] February calendar indexes may be computed as follows:

(1) Non-leap-year Index = 99.1
(2) Leap-year "a" Index = 102.7 + 0.155 (a–d)
(3) Leap-year "b" Index = 102.7 + 0.155 (a–d) – 1.085 (a–b)
(4) Leap-year "c" Index = 102.7 + 0.155 (a–d) – 1.085 (a–c)

XI. The effects of calendar shift in the original series may be removed by dividing by the indexes derived in VIII, Line (4), and in X, and multiplying by 100.

COMPUTATION OF CALENDAR SHIFT INDEXES

	Type of Calendar Link Relative	Broadened Median Calendar Links (1)	Product (2)	Root of Product (3)	Adjusted Calendar Links 100 (1) ÷ (3) (4)
Step V	a/d	106.0	10,112.40	100.56	105.41
	d/a	95.4			94.87
	b/a	98.8			97.95
	c/b	99.8	1,026,450.984	100.87	98.94
	a/c	104.1			103.20

Step VI

$$d/c = \frac{a/c \times d/a}{100} = \frac{94.87 \times 103.20}{100} = 97.90$$

Step VII

$$\frac{d/c + b/a}{2} = \frac{97.90 + 97.95}{2} = 97.92$$

Step VIII

(1)	105.41	97.92	98.94	97.92	
(2)	105.41	103.22	102.13	100.00	
(3)	.48	.14	.14	.24	Wtd. Avg. = 103.35
(4)	102.0	99.9	98.8	96.8	

Step IX

$$\frac{\text{Saturday}}{\text{Week Day}} = 1 - \frac{30.66\,(102.0 - 99.9)}{100 + 4.38\,(102.0 - 96.8)} = 1 - \frac{64.4}{122.8} = 48\%$$

$$\frac{\text{Sunday}}{\text{Week Day}} = 1 - \frac{30.66\,(102.0 - 98.8)}{100 + 4.38\,(102.0 - 96.8)} = 1 - \frac{98.1}{122.8} = 20\%$$

Step X

February Indexes

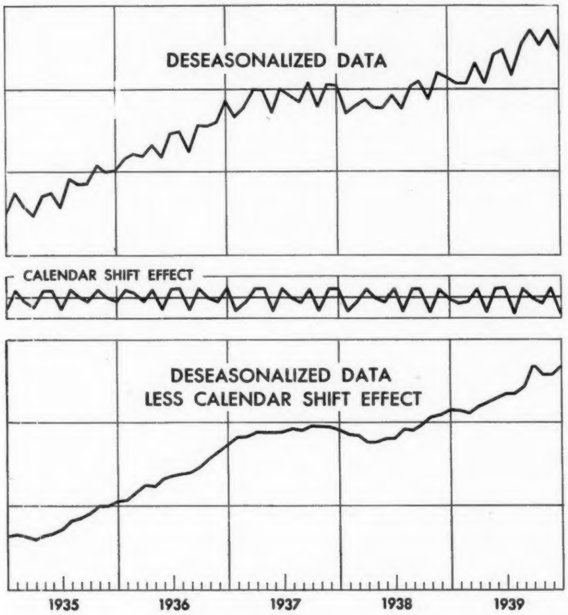
Non-Leap Year Index = 99.1
Leap-Year "a" Index = 102.7 + 0.155 (5.2) = 103.5
Leap-Year "b" Index = 103.5 – 1.085 (2.1) = 101.2
Leap-Year "c" Index = 103.5 – 1.085 (4.2) = 100.0

Example of Application

The adjoining table and chart show certain phases of the application of the above procedure to a typical economic series. The table shows the computations involved in Steps V to X of the procedure. The first four steps are not shown, as they are relatively simple

and should present no difficulty in practice. The chart shows the comparison of the data before and after calendar shift adjustment. As can be seen from this chart, the adjustment for calendar shift results in a noticeably smoother curve. In many cases, of course, the smoothing effects of the process will not be as marked as in this example.

THE EFFECTS OF CALENDAR SHIFT ON AN ECONOMIC SERIES



NOTES

1. For refined measurement of seasonal variation, it may be desirable, in some cases, to recompute the seasonal indexes from the original data after adjustment for calendar shift.
2. Computed by averaging the items remaining after eliminating the noticeably high and low values in equal numbers.
3. If such a chart shows changing calendar characteristics, the over-all period may be broken into several portions and a separate calendar analysis (Steps IV-X) made for each portion. However, calendar indexes computed from less than four or five years data may not be too reliable.
4. The first chain value (a/d) is the same as the link value immediately above. Subsequent chain values are computed as (Value to left $\times$ value above) $\div$ 100.
5. These weights reflect the frequency of occurrence of the four types of months. The weighted average is derived by multiplying each of the chained relatives in line (2) by the weight immediately below in line (3), and adding the four products so obtained.
6. These values are at best reliable only to the last full percent. They represent the proportionate values of Saturdays and Sundays as compared with week-days, for those monthly series in which a more or less definite value accrues for each day of the month. An example of this type of series is the payroll associated with weekly-paid employees.

   For series of the true monthly type, such as rents or the payroll of monthly-paid employees, Saturdays and Sundays have equal status with week-days in that they do not affect the monthly values. In such series, there is no calendar shift effect, and the indexes in Step VIII should theoretically all be 100.

   N.B.—If, considering the series involved, the Saturday and Sunday values appear unreasonable, it may be the result of erroneous computation, or the presence of freak or inconsistent calendar shift effects. In the latter case, the results of the process will probably not be reliable.
7. Although the calendar indexes determined in Step VIII, Line (4) apply to all non-February months regardless of type of series, the determination of calendar shift indexes for February is governed by the type of series. For a true monthly series, February calendar indexes, as well as all other calendar indexes, are 100. For a series of the daily type, February indexes may be computed as outlined in Step X.

   For data combining characteristics of both types of series, the *basic* February indexes should be altered by damping their deviations from 100 by a factor representing the proportion the monthly-type elements bear to the total. Information on this proportion may be gained from knowledge of the underlying nature of the series, or from consideration of the variations in the lengths of the months and their effects on the data.

The last line of the table in the first article on calendar shift effects, which appeared in the October issue, was printed in error. This section should have read:

Sunday	**Saturday**	**a**	**c**	**b**	**d**	**a**	**c**	**b**

This arrangement follows that used in trigonometric tables, and by avoiding duplicate listings, shortens the table considerably. It is suggested that the above changes be made on the copies of the table, since it will almost double the number of combinations of Saturday and Sunday values shown.

THE DEVELOPMENT OF STATISTICAL QUALITY CONTROL IN THE UNITED STATES

by S. B. LITTAUER

Introduction

The rather rapid spread of the practice of Statistical Quality Control in this country during and since the War has focused interest on its growth and development since its inception and presentation by Walter A. Shewhart some twenty-five years ago. In this article an attempt will be made to trace this development although it will not be possible within the limits of this brief discussion to give a detailed history.

It may be well to recognize at the outset that the expression "statistical quality control" means many things to many men, and that the word statistical is omitted from the expression by many persons who think of statistical quality control as being applied only to the control of the quality of manufactured products. It might be better in this limited connection, just mentioned, to use the expression industrial quality control. And even in this sense there are many practitioners who believe that statistical quality control is limited to the application of sampling techniques in inspection procedures. I believe that even a casual reading of Shewhart's two books[1] shows beyond any doubt that he was developing a general system of experimental inference. This system of thinking is essential to the economic control of the quality of manufactured product, and it is pricipally in this field of work that Shewhart's ideas have been validated and given extensive application. Hence this short account of the growth of statistical quality control will deal considerably with development in industrial quality control as well as with developments in statistics which resulted from interest in industrial quality control. In addition, the growth of formal courses of study of both statistics and industrial quality control is a part of this picture. The unifying feature, however, of these branches of the development of statistical quality control lies in its emergence as an established and practiced aspect of scientific method. The course of this development falls naturally into the following four periods:

1. Antecedents—the period before 1924.
2. The first five years—contributions of Shewhart and his associates, 1924-1929.
3. Extension and development through the war period, 1929-1945.
4. The present and future—1945 on[2].

1. Antecedents—the Period before 1924

Any cultural movement has its antecedents, although sometimes they are difficult to trace. The contributions of Shewhart, coming as they did so close in time to the quantum-mechanical developments in physics, would seem to derive from some common sources in statistical methodology. At any rate, it would seem natural to look for some sources in the methods and practices of industry and science, which suggested the conception of statistical control. Since Shewhart worked in the Bell Telephone System, it might be interesting to trace the connections there, where as early as 1903, Malcolm C. Rorty did fundamental work in applying the normal approximation to the binomial distribution for the solution of telephone traffic problems. Again, in 1905, Edward C. Molina, in connection with his pioneer work on dial telephone systems, followed up the work of Rorty with the design of a non-decimally functioning selector switch which improved the proficiency of trunking operations. In order, however, that subscribers might be able to operate these selector switches from a decimal dial, Molina was obliged to invent his "translation" system. It became more important then that he obtain a simple approximation for the binomial distribution for small values of np occurring in trunking problems, and by the close of 1907 he "rediscovered" the Poisson distribution[3]. Dr. George A. Campbell became interested in the Poisson distribution while checking Molina's results, and succeeded by 1913 in obtaining a series solution to the inversion problem. The traditions established by those men continues vigorously in the Bell Telephone System today.

It is reasonable to believe then, that when in the early twenties the Engineering Department of the Western Electric Company sensed the need for delving

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[1] *Economic Control of Quality of Manufactured Product*. Van Nostrand, New York 1931.

Statistical Method From The Viewpoint of Quality Control. (Edited by W. Edwards Deming.) The Graduate School, Department of Agriculture, Washington, D. C., 1939.

[2] No attempt is made here to give extensive references to the literature since this would be a task entirely beyond the scope of this article. "A Bibliography of Statistical Quality Control" by Grant I. Butterbaugh (University of Washington Press, Seattle, 1946) and the Statistical Methedology Index provide adequate coverage for any references suggested but not included here.

[3] It is interesting to note that in a paper by Rutherford and Geiger ("The Probability Variations in the Distributions of alpha-particles", Phil. Mag. Series 6, Vol. XX, 1910) is included a note by H. Bateman in which he also "rediscovered" the Poisson distribution as a solution of the differential equation for the deviations in the number of alpha-particles hitting a screen.

[4] "Average values based on data obtained from a large number of observations" by Karl Daeves, Stahl and Eisen, Vol. 45, Nos. 3 and 4, Jan. 15, and 22, 1925. This article contains a number of references to articles on "Grosszahlforschung" published in 1922, 1923, and 1924, by Karl Daeves and others engaged in the German steel industry.

into inspection engineering problems, the soil was fertile for the use of probability theory. There were also available the "Campbell Curves" and the "Molina Tables", which have been used so extensively in preparing acceptance sampling plans for use in statistical quality control practice today. Yet the connection between this climate of ideas and the specific contributions of Shewhart is nevertheless not immediate. For these earlier workers considered formal mathematical problems in probability theory related to particular applications, whereas Shewhart developed a system of ideas necessary for valid experimental inference, without which the task of controling the quality of manufactured product could not be effected. He introduced the necessity for "setting a goal", which in the case considered was economic in nature, and he provided simple operational means for attaining this goal, the state of "statistical control." Statistical control is essential not only for attaining and maintaining quality of industrial product but is also essential in other phases of industrial production as well as in experimental method in general.

The literature before 1924 is practically empty of any reference that might suggest statistical method in quality control and in particular of the concept of statistical control. One might expect something suggestive from G. S. Radford's "The Control of Quality in Manufacturing" (The Ronald Press, N.Y. 1922), wherein the author considered engineering and management aspects of quality control, but completely missed the concept of statistical stability. He recognized the need for a means for maintaining uniformity of product and he knew that defects in the final product reflected poor control of the manufacturing process. Radford also recognized that sampling might play a significant economic role in inspection practice, but his writings nowhere indicated his awareness of statistical method in experimental inference, nor did he in any way anticipate the concept of statistical control.

Some form of sampling inspection was, of course, practiced by industry before 1924. In fact, statistical methods were applied to inspection practices at the Western Electric Company for some time before the development of the Dodge-Romig tables. And it seems, from an article by George R. Diggles, entitled "Sampling for Test Purposes," which appeared in the *General Electric Review* (Volume XXV, No. 6, June, 1922), that some formal attempts at "scientific" acceptance sampling were made at the G. E. Lamp Works at that early date. Results indicate, however, that the early workers in acceptance sampling did not carry their ideas very far and that their work did not in any way anticipate Shewhart's ideas of statistical control.

The most fruitful use of statistical method in the search for production uniformity before 1924 can be found in the work of Karl Daeves, who referred to his efforts as "Grosszahlforschung."[4] Daeves was concerned largely with establishing frequency distributions and detecting the existence of more than one distribution. This work represents a search for homogeneity in manufactured products by means of statistical method, but contains no indication of the awareness of the importance of the time order of the observations, nor does it indicate a search for experimental criteria for valid prediction.

This article, outlining the history of development of Quality Control in the United States was prepared by Professor Littauer at the request of the Editors.

In this vein one might advisedly go back to "Student" who initiated an era of statistical inquiry quite different from that which commanded most attention before his day. Before his time statistical method was concerned with material mainly outside the natural sciences and applied principally to frequency distributions and to short range forecasing. According to a ranking member of the board of directors of Messrs. Guiness and Company of Dublin, it was their custom to appoint to their staff from time to time a "bright young" graduate from Cambridge or Oxford. When William Sealy Gosset ("Student") was taken on at the turn of the century, one of the problems giving his employers concern was the fact that replicate measures made in the laboratory did not check. In attacking this industrial problem in the classical theory of errors "Student" prepared the ground for the development of industrial statistics. While his work did not contain any direct suggestions of the ideas of statistical control, it may reasonably be considered to have been logically antecedent to the conception of statistical method from the viewpoint of quality control.

2. The First Five Years—Contributions of Shewhart and His Associates—1924-1929

Early in 1924, the awareness among Western Electric engineers and executives that the control of quality of manufactured product needed special inquiry, crystalized in the formation of an Inspection Engineering Department (now the Quality Assurance Department of the Bell Telephone Laboratories, an outgrowth by reorganization in 1925 of the Engineering Department of the Western Electric Company). One of the first appointees to this group, then, under the leadership of R. L. Jones, was Walter A. Shewhart, who was assigned to examine and interpret the inspection data covering production for the quarter year just completed. It was readily apparent to Shewhart that little useful inference could be drawn from the data, except that something serious should be done. Almost immediately he presented his first memorandum on the control chart and began his systematic development of the theory and practice of statistical quality control which was well rounded out by 1929. The first published description of the control charts appeared in *The Bell System Technical Journal* in October, 1926. An earlier article (December, 1925) in the *Journal of the American Statistical Association* introduced some of the basic ideas.

Karl Daeves' "Grosszahlforschung" dealt with frequency distributions of observations made in steel production, but neither he nor any other statistician provided a means for determining whether one had a

distribution. Considerable reference was made in the literature to the assumption of the existence of distributions and of randomness, but no reference was made as to how to obtain a distribution or a state of randomness. In 1924 Shewhart showed (operationally) how to determine that the source of one's observations behaved as though a distribution existed and how to bring about this state. Even today statisticians talk and write of formal tests of randomness without introducing an operational procedure apart from the mere taking of observations. Shewhart was not aiming at the development of statistical theory but at a "practical" goal, namely getting some information out of inspection data so as to obtain uniform manufactured product economically. In accomplishing this specific objective he formulated the general concepts of statistical quality control which represented a great step forward in the use of statistical method—it was a major advance in experimental method marked by the fundamental fact that the attainment of control required the setting of goal.[5] The methods of statistical quality control have experimental meaning relative to randomness in that the test for a state of control relative to a given goal is as far as one can go in testing randomness.[6]

As is often the case in major scientific advances, Shewhart conceived the principal notions of statistical control within the brief space of days and set down the essential developments of his ideas in a few memoranda and published papers appearing during the years 1924-1926. Nevertheless the soundness of the methods of statistical quality control were validated by an exacting testing program carried on by the staffs of both the Bell Telephone Laboratories and the Western Electric Company over a period of years. When they were made a part of the regular procedures of the production divisions, it was with reasonable assurance that they would work effectively. While the early dissemination of these results was limited in the main to the circulation of memoranda within the Bell Telephone System, a number of papers were published during the five years from 1924 through 1929, when many of the important ideas of statistical control were being worked out and reduced to practical procedures by members of The Quality Assurance Department. An important part of the integrated program of quality control carried on during these years was the development of sampling inspection tables associated with the names of Dodge and Romig and carried on under the direction of George D. Edwards.

When Harold F. Dodge joined the Western Electric Inspection Engineering Department, just a short time after Shewhart, it was known how to determine whether a distribution existed. When Dodge began developing sampling inspection tables, it might be said that he asked the question, "How large a sample?" Many of the results were quickly forthcoming, but the whole answer did not come all at once, and in 1926, when Harry G. Romig joined Dodge, they inquired into the problem of double sampling in order to reduce the size of samples required in single sampling of small lots. In 1926, the first set of the Dodge-Romig lot tolerance tables was completed, followed in 1927 by the first A.O.Q.L. tables. These tables were put into immediate use in the manufacturing plants of the Western Electric Company and have remained a part of standard practice there in process and final inspection.

The success experienced with double sampling led to the study of multiple sampling, tables for which were developed by Dr. Walter A. Bartky, of the University of Chicago, who originally joined in this work as a mathematical consultant in the preparation of some of the original tables. The use of multiple sampling tables did not become a part of standard practice in the Western Electric Company, where the economies in inspection were apparently not sufficient to offset the added difficulties in administration. In 1928 Romig wrote his first memorandum on variables sampling which he followed up by a complete set of tables paralleling those by Dodge and Romig for attributes. These plans are in current use. The joint efforts of Dodge and Romig were represented by only one published paper in the early days, namely "A Method of Sampling Inspection" (*B.S.T.J.*, October, 1929). In the meantime, P. P. Coggins presented some interesting material in "Some General Results of Elementary Sampling Theory for Engineers"—*B.S.T.J.*, January, 1928).

Space does not permit chronicling all of the work done in the Bell Telephone System during even the first five years of the development of statistical quality control. A new science had been built up, tested and put into practical use, in which statistical method was an intrinsic part. Interestingly enough, this work was done by men who were engineers rather than statisticians. Statistics was pragmatically employed in establishing a valid basis for experimental inference and for the study of randomness; the concept of control limits as action limits was added to the statistical inferential apparatus. The use of concepts of the consumer's and the producer's risk in the employment of sampling tables were early expressions, extensively validated, of the presently accepted theory of testing hypotheses. Practically all of the important features of sampling inspection were developed during this period, which may be considered to close the basic stage of the development of industrial quality control. The principal work was done by Shewhart and his associates at the Bell Telephone Laboratories. The motive as well as the applications seemed to be primarily industrial. Publication on the subject was not extensive. Yet when the work of this period was presented in 1931 by Shewhart in his first book[7] statistical quality control was an established major development in scientific method.

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[5]It may be interesting to compare the concepts of statistical quality control with those of experimentalism, associated with the name of E. A. Singer, as set forth in "The Theory of Experimental Inference" by C. West Churchman (The Macmillan Company, New York, 1948).

[6]The control chart seems to offer a simple example of the application of the concept of negative entropy to the transmission of a message, discussed by Norbert Wiener in "Cybernetics" (John Wiley and Sons, N. Y., 1948).

[7]Cf. Ibid.

3. Extension and Development Through the War Period, 1929-1945.

It would have seemed natural at this stage that the knowledge and use of statistical quality control be extended to wider horizons, and this the founders of the new science undertook to do with typical thoroughness. However well an organization controlled the quality of its own manufacture it was dependent on the quality of its raw materials, purchased parts, and on the prevailing practices of quality control, even in the most distant places. In order that the economic and social benefits of industrial quality control might be most fully experienced it was necessary to awaken the interest of engineers as well as of statisticians.

One of the first efforts in this direction was the formation, under Shewhart's chairmanship, on December 5, 1929, of the Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing, sponsored by the American Society of Mechanical Engineers and the American Society for Testing Materials and joined by the American Statistical Association, the Institute of Mathematical Statistics, and the American Institute of Electrical Engineers. Journals of these societies eventually carried articles on statistical quality control and statistical methods in engineering. *Mechanical Engineering* carried in its November 1932 issue a Joint Committee report on applications (with a bibliography appended).

On June 23, 1930 the Technical Committee on the Interpretation and Presentation of Data (subcommittee of Committee E-1 on Methods of Testing) was formed under the sponsorship of the A.S.T.M. In the Chairman's report for 1930-31, Shewhart presented a discussion on "The Logic of Discovery Basic to the Acquisition of Good Data." In 1933 the Committee published the first section of the A.S.T.M. *Manual on the Presentation of Data,* followed in 1935 by Supplements A and B, which included an exposition on control charts.

The armed services were brought into the picture at Picatinney Arsenal, when L. E. Simon (then lieutenant in the Ordnance Department of the U. S. Army) began his quality control work in 1934. General Simon not only made many important contributions to the practice of quality control but was instrumental in getting the armed forces to promote nationwide use of statistical control and thereby materially helped the armament and procurement program. In 1936 the Bell Telephone Laboratories were invited to cooperate with the Army Ordnance Department, and together, Shewhart and Simon interested the War Department in sponsoring the formation of the American Standards Association Technical Committee to develop war standards for quality control. Under the chairmanship of Harold F. Dodge there were published (and very extensively used) *American War Standards Z1.1, Guide for Quality Control* (1941), *Z1.2 Control Chart Method of Analyzing Data* (1941), and *Z1.3 Control Chart Method of Controlling Quality During Production* (1942). Shewhart and Simon were also instrumental in spurring on the sampling inspection program, to which Edwards was invited as consultant in charge, together with G. R. Gause (the with Army Ordnance) and Dodge and Romig. In 1942 they completed Army Ordnance Standard Sampling Inspection Tables I-VI on fraction defective, and in 1944 Tables VII-XII, all now part of Standard Inspection Procedures of the Army Service Forces. The use of these tables was introduced into the armed forces by means of a number of intensive training courses.

On July 1, 1942, Warren Weaver, Chief of the Applied Mathematical Panel of the National Research Defense Committee, Office of Scientific Research and Development, organized the Statistical Research Group. During the three years of its existence it made many contributions which have bearing on statistical quality control, most notable of which is the work of A. Wald on *Sequential Analysis,* carried out in 1943 and discussed in a number of publications, culminating in his book by that title (Wiley & Sons, New York, 1947). Much of the work of this group which is of interest to workers in quality control is contained in the two volumes *Sampling Inspection* and *Selected Techniques of Statistical Analysis* (McGraw-Hill, New York, 1947), prepared under contract between the Trustees of Columbia University and the O.S.R.D.

Again in 1942, the Joint Committee (referred to above) was instrumental in encouraging Dr. Harvey Davis, then Director of the Office of Production Research and Development, to set up the OPRD program in quality control, which will be referred to later in the discussion on training.

The Navy's interest in statistical quality control was stimulated by Shewhart and Jewett (formerly Director of the Bell Telephone Laboratories) and, late in 1942, John H. Curtiss was brought to the Bureau of Ships to develop its program.

When in 1943, the National Research Council Committee on Applied Mathematical Statistics was formed, significant progress had been made in speeding and intensifying interest in statistical quality control and statistical applications to engineering problems among the professional groups which might fruitfully use the new methods and techniques. In both private industry and in the Armed Forces, enough knowledge had been assimilated so that the urgent requirements of economic production and "high quality" for the war effort could be met.

In spite of this effort, however, external signs of the development of quality control during the 1930-1940 decade were but few, whether in publications, education, or industrial activity. There were, however, some notable signs, beginning with the publication of Shewhart's "Economic Control of Quality of Manufactured Product" (referred to above), which presaged the intense tempo of activity that marked the war years. Among the periodicals, following the appearance of the report of the Joint Committee in 1932, *Mechanical Engineering* presented a steady succession of papers. Sales of the A.S.T.M. Manual on the Presentation of Data warranted additional printings. Shewhart himself, in 1930, gave the first college course in statistical quality control at Stevens Institute of Technology, using his manuscript notes as a text. Two years later a course was introduced at Columbia

University, which has remained a regular part of the Industrial Engineering Curriculum. When in 1939 Romig published his work on the "Allowable Average in Sampling Inspection" — a system of sampling inspection by variables — it was as a doctoral thesis at Columbia University, the first in the field of statistical quality control.

No doubt other quality control courses were given at a number of institutions — but formal training in this field did not grow to any extent until the war years. There were, however, a few interesting special teaching programs, such as the lecture series on "Statistical Method from the Viewpoint of Quality Control" given by Shewhart at the Graduate School of the U. S. Department of Agriculture in Washington, D. C., in 1938, and the M. I. T. Conference held later in the same year. The teaching done on these occasions not only reached active practitioners of statistics and industrial production but was given lasting value by the publication of Shewhart's lectures (under the same title) with the editorial cooperation of W. Edwards Deming and of the "Proceedings of the Industrial Statistics Conference Held at Massachusetts Institute of Technology, September 8-9, 1938" (Pitman, New York, 1939). The M.I.T. Conference attracted wide attention among industrial executives because of its distinguished group of lecturers and because of the presence of L. H. C. Tippett from England, whose work had special appeal to the textile manufacturers of New England.

By 1940 the tempo of quality control activity was stepped up considerably as a result of the organized efforts made during the preceding ten years to arouse the interest of various professional and industrial groups. In the few years following, the practices of statistical control received much wider acceptance, and many contributions, both practical and theoretical were made. The armed forces did much to encourage the participation by industry and to enlist the interest of matahematical statisticians in their quality control problems.

Much of this effort took place in the Army Ordnance Department, where, in 1942, following the promotion of such publications as the American War Standards and the Ordnance Sampling Tables referred to above, the Armor Plate Quality Control Plan was initiated with a salutary influence on industrial practice, as well as immediate practically beneficial results. This program and others, such as the one started in 1943 on steel castings, did much to enlist manufacturers active participation in statistical control methods. Again it was in the Navy where interest originated, which led to the development of Wald's sequential analysis. In 1944, the SRG, Columbia University, put out *Sequential Analysis of Statistical Data, Applications* (SRG 255, OSRD 3926), which was made available to war contractors for use in quality control problems of manufacture. Also in 1944 the Quartermaster Corps of the Army had H. A. Freeman and D. Schwartz prepare sequential tables matching the Army Ordnance single and double sampling tables. Sequential plans were put into active use by consultants moving around the country to various contractors for the military. Later in 1945, the Navy, which had in the three years preceding made extensive use of the existing sampling table, commissioned the SRG of Columbia University to prepare a comprehensive manual on attributes inspection plans, which became *Appendix X* of the Navy Department's *Specification for General Inspection of Material.* The work done in preparation of this manual became the basis of "Sampling Inspection" referred to earlier.

Many readers undoubtedly have observed at first hand the influence of these activities on the part of the Armed Forces on the practices of quality control in industry. With the adoption of the various acceptance sampling procedures by the inspection divisions of the services, an act commonly referred to as "going on quality control," there followed, in general, rather intense efforts on the part of the companies affected to study and implement the principles of statistical quality control. To a large extent the currency of the statistical viewpoint prevailing in industry today has resulted from just such experiences gained during the war.

Supplementing these activities there was the nationwide quality control program, initiated informally in 1940 as part of the federal government's Engineering Defense Program. A full account of the extent and influence of subsequent training activities has been given by Holbrook Working,[8] who, with E. G. Olds and Paul Beach, conducted the Office of Production Research and Development Quality Control Program, which was initiated as a result of proposals made by Shewhart, first on behalf of the Joint Committee for the Development of Statistical Applications in Engineering and Manufacturing, and somewhat later (January 1943) on behalf of the Committee on Applied Mathematical Statistics of the National Research Council. The plan of the intensive eight-day courses given under OPRD auspices at various unversity centers was originally developed at Stanford University by Working, E. L. Grant and W. Edwards Deming in 1942. There, as part of the Engineering, Science and Management War Training Program, facilitated by the U. S. Office of Education which provided funds and administrative assistance to training centers primarily for evening and in plant courses, the first intensive courses for men in industry were given. These courses

[8]"Statistical Quality Control in War Production," *Journal American Statistical Association,* December, 1945.

[9]Luncheon meeting, Institute of Mathematical Statistics, Detroit, Michigan, December 27, 1938.

[10]*Annals of Mathematical Statistics,* March, 1941.

[11]Other books during this period:
- "Poisson's Exponential Binomial Limit" (Poisson tables), Van Nostrand, New York, 1942.
- "Industrial Statistics," H. A. Freeman (Wiley, New York, 1942).
- "Sampling Inspection Tables—Single and Double Sampling Tables," H. F. Dodge and H. G. Romig, Wiley, 1944.
- "Management of Inspection and Quality Control," J. M. Juran, Harper & Brothers, New York, 1945.

[12]Published as "Fluid Mechanics and Statistical Methods in Engineering," University of Pennsylvania Press, Philadelphia, Pennsylvania, 1941. Articles by Wilks, Shewhart, Simon and Pound.

[13]*Statistical Methods in Quality Control,* Engineering Data Book, Section 29, prepared by G. R. Armstrong and P. C. Clarke.

were supplemented by a number of one-day follow-up sessions. When the OPRD program was initiated provision was made for one-day sessions for executives and additional training for teachers.

Wartime training in quality control reached upwards of 10,000 persons in all levels of work and in all varieties of industry and commercial and public endeavor as well. It is not possible here to give adequate appreciation of the valuable influence which these training programs exercised on the development of statistical quality control on a nationwide scale and of their contribution to the total war effort. The existence and the active influence today of the American Society for Quality Control, organized on February 16, 1946 by representatives of seventeen local quality control societies (and since joined by other local groups) which formed spontaneously among the enrollees of the eight-day intensive courses, is real enough testimony to the lasting value of the OPRD Quality Control Training Program. By the close of the war a remarkable job had been done in fundamental training and in engendering a genuine and permanent interest in more advanced training, as evidenced by the activities of the various sections of the ASQC.

One of the best measures of the growth of a subject is found in the publications on it. In the present decade articles on statistical quality control were published in considerable number, including all shades of contribution from the fundamentally important to the interestingly superficial, and from the mathematical to the promotional. The *Annals of Mathematical Statistics,* following publication in March, 1939, of a summary of Shewhart's address on "The Future of Statistics in Mass Production,"[9] became host to a number of papers on the theory and applications of runs, the establishment and practical use of tolerance limits, sampling runs for continuous production, the first non-classified account of Wald's sequential analysis and other interesting topics directly or indirectly related to quality control. At least one of these papers was written directly in response to a question proposed by Shewhart because of its operational importance, and which he discussed at some length in his second book. The confidence interval was quite familiar in statistical methodology, but the tolerance interval had not been established – that is, a statistical method had not been found for experimentally detetrmining a tolerance interval. Because of the importance of the tolerance interval in the preparation of specifications the problem was proposed to a number of statisticians. S. S. Wilks presented the distribution free solution in his fundamental paper "Determination of Sample Sizes for Setting Tolerance." This result represents a fundamental step in statistical methodology deriving from quality control, which added to the confidence interval represented by the 'Student' range,[10] the action interval determined by control limits and the probability interval determined by tolerance limits. The work of mathematical statisticians continues to receive motivation and stimulus from questions arising in quality control, and the language of quality control finds frequent expression in their papers.

The *Journal of The American Statistical Association,* which published a paper by Shewhart as early as 1925, continued to present many articles on a variety of applications of statistical control techniques to such diverse fields as the verification of punch card operations, the anticipation of epidemics, or the control of overtime employment. This periodical also carried many reviews and its Statistical Methodology Index did invaluable service in its coverage of current literature. Journals in fields like marketing and accounting began to carry articles on the use of control charts and sampling tables. All fields of manufacture came to be represented in the periodical literature.

Then, a result of the now growing interest in industrial quality control, a number of books appeared, led off by L. E. Simon's "An Engineer's Manual of Statistical Methods" (Wiley, 1941) which found its way into college classrooms as well as into industrial plants.[11] A few other monographs worth mentioning also made their appearance. The University of Pennsylvania Bicentennial Conference Lectures on Statistical methods in Engineering [12] contained a new and interesting note offered by Dean Roscoe Pound in his paper "Relation of Statistical Quality Standards to Law and Legislation." This article pointed to the fundamental fruitfulness of Shewhart's ideas of statistical control as instruments of experimental inference in showing their potential effectiveness in the administration of law so as to serve the social purposes for which legislation has been designed.

In 1944 a number of publications appeared under specific industrial sponsorship. The Production Handbook (Ronald Press, New York) devoted Section 10 to an excellent practical reference treatment of statistical quality control, written by A. I. Peterson. The Hunter Pressed Steel Company (now Hunter Spring Company), one of the pioneers in sound practice of industrial quality control, put out a hundred-page monograph, Section 29 of its Engineering Data Book,[13] which was made available to customers and other interested persons. This manual might well serve as an effective supplementary text for a short training course for operating personnel. The aircraft industry through the Aircraft War Production Council, Inc., after having made a comprehensive study of existing statistical quality control practices in its field, published under the title, "Statistical Control of Quality For the Aviation Industry," a 96 page monograph (mimeographed and paper covered, prepared by D. D. Pettit and E. E. Bates) for the information and use of the various manufacturers engaged in wartime aircraft production.

The developments during the period just considered may be charactetrized as extensive when compared to those of the 1924-1929 period which were indeed intensive. Shewhart created the basic ideas and philosophical foundations of statistical quality control and together with his associates in the Bell Telephone Laboratories worked out the techniques and operating principles necessary for the practical implementation of his original idea. And together with the production and operating branches of the Bell Telephone System the operational validity of statistical quality control was established. In the second period Shewhart initiated and guided the

extension of these ideas to the scientific, professional and industrial groups which were to implement statistical quality control in all its phases on a nationwide and ultimately on an international scale. This program of extension was so well set in motion by 1940, that effective technical and economic use of Shewhart's original conceptions were realized in the extensive production program of the war years. While the decade ending in 1940 was not marked by many of the outward signs which usually designate the emergence of a science and its practice, the next five years bear testimony to the establishment of statistical quality control as a working scientific methodology and as a valid system of operating procedures. The emergence of a quickened tempo in publication, practical application and education was bold indication that a new science and its practice had attained nationwide acceptance.

JOHN M. GLENN

John M. Glenn died on April 20, 1950. Then ended a notable career which carried well into his 92nd year. For the 24 years up to 1931 he was General Director of Russell Sage Foundation, and was regarded by many as the dean of social work in the United States. For over 36 years he was a member of the American Statistical Association.

While not a professional statistician, Mr. Glenn had a deeply-lodged and long-sustained appreciation of the importance of facts, their careful assembly and intelligent interpretation in dealing with social, economic, educational and other questions; this interest was greatly enhanced by some early experiences. He never forgot how, when working for child labor legislation at about the turn of the century, a few well-marshalled facts vastly outweighted theoretical arguments and, alas, even those based on moral grounds. Another instance came along about 1912 when the report of a study sponsored by Russell Sage Foundation came to him in its final steps toward publication. It included statistical data, and his eye fell upon figures which aroused his doubts. Though methods of social statistics were then in their infancy, the application of ordinary standards of arithmetical accuracy and adequacy of data by a staff member, to whom the report was submitted for critical review, resulted in conclusions so devastating that the report never saw the light of day. From then on statistical scrutiny of Foundation studies became a regular part of the organization's routine, applied in some cases in the study-planning stages and in all cases as findings progressed toward publication.

Mr. Glenn's 50 years and upwards in work to improve social and living conditions coincide with an important and rapid-moving period in the social history of this country; and, while he would have been the last to claim it, he played an influential role in the unfolding scene. He recognized that the direct instruments for social action in a democracy are legislation and public administration; but he also saw as an indispensable prerequisite for sound democratic progress the development of enlightened public opinion, and that reliable facts are the raw materials of such opinion. And, as a corollary to this requirement, he believed that factual material to be reliable (and also effective) demanded, as already suggested, skillful gathering, analysis, interpretation and widespread dissemination. It seems altogether probable that convictions like these, put into effect in the many studies under his general supervision, contributed substantially to the increasing recognition during recent decades of the undeniable place of social research in facing new frontiers, local, national and world-wide.

—*Shelby M. Harrison.*

NEWS CONTINUED

Statistician Honored for Interracial Work

Lou Montgomery of Hartford, Conn., a statistician of the Royal Typewriter Company, was one of the two recipients of the 1950 James H. Hoey Awards for outstanding promotion of the cause of interracial justice. Mr. Montgomery, a former mathematics teacher who was an all-American choice for fullback at Boston College, received the award at a ceremony at the Carroll Club in New York in November. He is one of the founders of the Hartford Catholic Interracial Council.

North Carolina Doctoral Degrees

The following Ph.D. degrees with major in mathematical statistics were granted at the University of North Carolina in 1950. Raghu Raj Bahadur—Thesis: On a class of decision problems in the theory of R populations; Kenneth Arthur Bush—Thesis: Orthogonal arrays; Max Halperin—Thesis: Estimation in truncated sampling processes; Sharad-Chandra Shankar Shrikhande—Thesis: Construction of partially balanced designs and related problems; and Shantilal Amidas Vora—Thesis: Bounds on the distribution of chi-square.

A SIMPLIFIED RANKING CHART

by Kenneth W. Haemer

This article describes a type of ranking-chart that is very much simpler than the old fashioned ranking-chart, and is therefore much more effective.

Like any ranking-chart, this one is actually a graphic table, with items listed down the side and categories or attributes across the top. It differs from the old fashioned variety in that the items remain in *the same order* in every category. General rank is indicated by a simple shading scheme; specific rank by a rank number. In the old style ranking-chart the items were actually rearranged in *order of rank* under each category. This necessitated zig-zagging connecting lines or a different shading for each item, to identify the item across the page. The result was often an almost undecipherable maze that presented no clear-cut visual image except one of confusion.

This simplified chart is easy to make and to understand. However, there is no denying that it is a strange looking device, and that many readers will blink their eyes the first time they see it. On the other hand, most of the chart forms we now take for granted were once just as unfamiliar; and after you have gotten over the first shock, you will find that this is a very useful chart for summarizing multiple comparisons, especially when the categories are not all measured in the same units.

In this form of presentation, magnitudes are represented only in a general manner, by showing which of a few broad levels they fall into. (Instead of the three divisions used in the illustration, it is sometimes more appropriate to divide the items into four groups, especially when the number of items is large enough to make quartiles significant.)

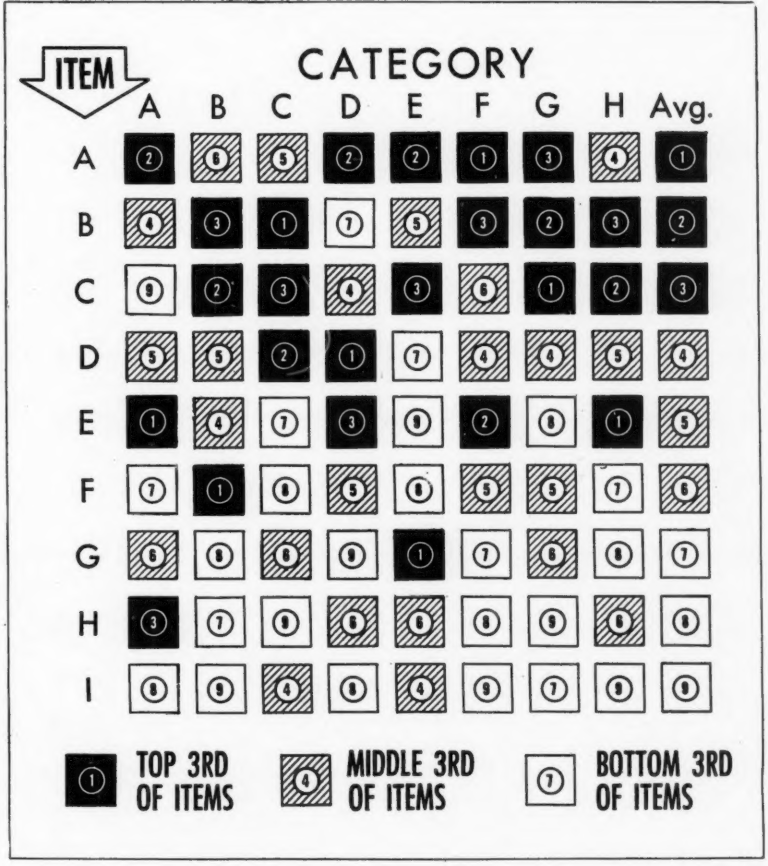
Division of the items into equal rank-groups is usually the most logical way to use this method; but it is effective also for unequal groups when such a treatment is suitable. For example, instead of 'top third', 'middle third' and 'bottom third'—as illustrated—the groups might be 'more than x% above average', 'within x% of average', and 'more than x% below average'.

With ranking charts of this type, it is possible to see very quickly how each item ranks in each of several categories and, reading the other way of the page, how the items are distributed in each category. As a sort of graphic inventory, it points out each item's high spots and low spots, and—when an average or total column is included—how the component influences behind this general measure combine to produce it. For example, the accompanying chart shows at a glance that item A was in the top two thirds in every category, in the top third in five; item E ranked only fifth in spite of high ranking in half the categories: item I was in the lower two thirds in every category and ranked last or next to last in more than half of them. Further study of the picture will disclose additional information of this kind. (Note that the items are presented in the order of their over-all rank.)

Of course summarizing always means simplifying. In the type of chart illustrated, actual magnitudes are not pictured; but instead, the chart merely sorts the items into a few levels of performance or results, to provide a general evaluation. The story is made somewhat more precise by the inclusion of the rank-numbers, but even with this added help, there is no way of knowing from this picture whether the difference between any two consecutive items is small or large. Of course, one way of handling this problem is to insert actual values in the blocks instead of rank-numbers, but obviously this is robbing Peter to pay Paul. In addition, it is seldom effective unless the figures can be rounded to 2 or 3 digits. But, with any chart there is a limit to the number of services it can perform; and this one is not intended for graphic presentation of precise values or small differences.

However, despite its lack of precision, this general form of ranking-chart is a valuable tool because it provides a quick, over-all view that would not be possible if the data were shown in more detail. In fact, a summary chart such as this sometimes can tell the story so well that the detailed data are not needed; but even when it must be supplemented by more precise charts or tables, this kind of over-all view can be very good insurance against getting so close to individual details that you can't see the forest for the trees.

Production note: The blocks are made by drawing only one complete set (1 through n), and then reproducing as many sets as needed by photostat or some other suitable duplicating process. The reverse blocks (white on black) are photostat negatives of black-on-white drawings. (These are made first, then pasted in place, together with the shaded and open blocks, to form the original complete set of ranking designations.) The chart is prepared by the cut-and-paste method, using double-scotch tape or some other appropriate adhesive. To facilitate pasting the blocks in perfect alignment, the columns and rows should first be drawn *in light blue pencil,* the intersection of each column and row forming a four-sided block location.



CHAPTER NOTES

CENTRAL INDIANA

Speaker of the first dinner meeting of the Central Indiana Chapter on September 28, 1950 was Mr. Robert E. Straszheim. Mr. Straszheim is agricultural statistician with the U. S. Department of Agriculture and Purdue Extension. He discussed the reports compiled and released by the Department and some of the techniques used.

CENTRAL NEW JERSEY

At the September 28 meeting N. Frederiksen and Wm. B. Schrader spoke on "Comparison of Veteran and Non-Veteran Studies." On October 27, Dr. Max A. Woodbury spoke on "General Information Theory."

Dr. Joseph Hochstim, President of the Chapter, resigned as of September 30, 1950 since he had accepted a position with the Bureau of Labor Statistics in Washington, D. C. and was leaving the area. Vice-president elect Wilbert E. Moore assumed the presidency and K. A. Brownlee was designated as vice-president, subject to ratification by members of the Chapter.

Committee chairmen include K. A. Brownlee for program and M. A. Woodbury for membership.

DENVER

H. E. Forsyth, Chief of Police in Denver, spoke at the November 9 dinner meeting of the Chapter on "Statistics in Crime Prevention."

DETROIT

"How Far Can We Trust Economic Statistics" is the subject at the Detroit meeting, and will be followed by a panel on uses of economic statistics in February. William H. Flaherty, Chief Statistician of Chrysler Corporation and Vice-President of the Detroit Chapter was the speaker.

The November meeting heard a speech by Donald R. G. Cowan, on "What's Happening to Coal."

Carter Bowen has prepared a Constitution which will be presented to the membership shortly.

Annual dues of $2.00 have been established and collection will start in November.

Lawrence Seltzer will be the moderator on the panel of the uses of Government Statistics in February.

NEW YORK

At the annual meeting of the New York Chapter, the following new officers were elected: Vice President, Dr. Meredith Givens, Director of Research and Statistics, Division of Placement and Unemployment Insurance, New York State Department of Labor; Executive Council, Donald Woodward, Second Vice President Mutual Life Insurance Co.; and Treasurer, Frank A. De Hermida, Assistant to the President, West Indies Sugar Corp. The other officers continued in office for one more year.

The Techniques Division is planning a series of seven monthly meetings beginning in November.

The annual fall business outlook meeting was held on November 30 at the Hotel Shelton. The speakers were Lewis B. Shellback, Vice President of Standard & Poor's, and Harold B. Dorsey, President of the Argus Research Co. The moderator was James F. Hughes, of Auchincloss, Redpath & Parker, Inc.

The New York Chapter has initiated a monthly newsletter, which will publish news of meetings and other events of interest to members.

PHILADELPHIA

The Philadelphia Chapter of the American Statistical Association held its first dinner meeting on Friday, October 27. Dr. Louis Levine, Chief, Division of Reports and Analysis, Bureau of Employment Security, U.S. Department of Labor spoke on "Man Power Mobilization for National Security."

This was the first of three meetings planned on aspects of the current preparedness effort. The second will present some financial and economic considerations, and the last will emphasize the industrial viewpoint.

ST. LOUIS

The September 27 luncheon meeting included a panel discussion on the "1950 Census of Population." Roy Wenzlick presented releases already received from the 1950 Census, Benjamin J. Scheve discussed plans for Census publications. James Appel reported on the preparation of metropolitan base and outline maps and Edward Olds spoke on the preliminary population counts and the type of data to be available by enumertion districts and blocks.

At the October 31 luncheon meeting, Howard Whipple Green's topic was "What Does the Real Property Inventory Do for Cleveland?"

UNIVERSITY OF ILLINOIS

At the October 19 meeting, statistics at the University of Illinois were surveyed by W. A. Neiswanger, Economics; E. J. Working, Agricultural Economics; R. B. Cattell, Psychology; F. G. Cornell, Education; J. A. Henry, Engineering; W. G. Madow, Mathematics.

WASHINGTON

On October 30, the Washington Statistical Society and the District of Columbia Sociological Society joined forces in a dinner in honor of Philip M. Hauser. Dr. Stuart A. Rice was toastmaster and the mysterious Mr. X turned out to be Louis Bean.